Geological Survey of Victoria

SURFACE GEOLOGY ALONG THE ROUTE OF THE PROPOSED DANDENONG VALLEY TRUNK SEWER

(Report for the Melbourne and Metropolitan Board of Works)

A. M. COONEY
17th May, 1973

SURFACE GEOLOGY ALONG THE ROUTE OF THE PROPOSED DANDENONG VALLEY TRUNK SEWER

(Report for the Melbourne and Metropolitan Board of Works)

A. M. COONEY
17th May, 1973

TABLE OF CONTENTS

TABLES

Following Page No.

APPENDI~~X~~CES

ILLUSTRATIONS

FIGURES

PHOTOGRAPHS

PLATES

SUMMARY AND CONCLUSIONS

A 1:25,000 map of the surface geology along the proposed route of the Dandenong Valley Trunk Sewer (Fig. 1) has been prepared and is appended to this report (Plate I).

Outcrops are rare in the project area; consequently, detailed topographic analyses were carried out in addition to the normal geological mapping, as an added tool in interpretation. The current Melbourne and Metropolitan Board of Works drilling will clarify much of the geology.

SUMMARY OF THE GEOLOGY ALONG THE PROPOSED ROUTE

A summary of the interpretation as it occurs along the proposed route is presented below. This summary commences at the northern end of the Sewer and the chainages given below refer to the section line AB (Plates I & II) which. ~~This section line~~ is more or less coincident with the proposed route.

All bearings are referred to the lines of longitude of the grid shown on the appended map.

Joint set orientations quoted below are representative ones based on stereographic plots of numerous readings.

0 - 900m Interval along section line AB

1) The mapping shows that sediments of the Anderson Creek Formation occur over this interval. Lithology is typically massive siltstone up to 1m thick. In addition, massive coarse grained sandstones (greywacke) 1-3m thick may be present.

2) The apparent dip should be approximately 50° southerly - along the direction of the sewer.

3) The main joint direction should strike 138° and dip vertical (138°/V). Other joint sets are 012°/V, 028°/V and 064°/V.

4) No complete exposure of the weathering profile has yet been recorded nor has boring yet penetrated it. However, weathering should be shallower and less intense than in most other parts of the project area as erosion has been relatively active here. Weathering would probably be greater at any fault or intrusion. Outcrops exhibit

Zone 2-3 weathering (see appendix 1).

5) No fault is anticipated along the interval but a possible zone of faulting striking 010^{0} would occur some 300m to the west of the proposed route if projected from its postulated occurrence at High Street, Rd.

900m - 3400m Interval along section line AB

1) The mapping shows that sediments of the Dargile Formation occur over this interval. Lithologies are interbedded sandstones and siltstones with beds varying between 12mm and 30cm thickness. There are also massive siltstone beds 1-5m thick. The siltstone forms 75-80% of the sequence.

2) The apparent dip along the direction of the proposed route should be approximately 50^{0} southerly along the line of the route.

3) Joint directions should be as described above for the 0-900m interval.

4) Weathering of the thicker siltstone beds should be similar to that occurring in sediments of the Anderson Creek Formation. However, siltstone in the interbedded siltstone - sandstone sequences are frequently highly weathered in outcrop (Zone 1B-2) - particularly near faults. Depth of weathering is not known.

5) The possible fault zone mentioned above would occur 500m to the west.

6) A postulated fault striking 035^{0} would occur at 3,400m. This is the Brushy Creek Fault, which if present, would be a major feature as it is believed to extend many miles to the north and possibly to the south.

3400 - 9000m Interval along section line AB

Outcrops are very rare over this interval.

1) Sediments of the Humevale Formation should occur over this interval. Lithology is massive mudstone beds 0.3-1m thick.

2) Apparent dips along the direction of the proposed route

should be 8° or less southerly over the first half of the interval and 8° or less northerly over the second half.

3) The main joint set should be 103°/V with other sets being 021°/62E, 035°/V, 054°/46NW, and 170°/29SW. However, these sets are based on readings from only two outcrops - both of which occur at the northern end of the interval.

4) In a quarry exposure slight to moderate weathering (Zones 4 to 5) of the mudstone occurs at a depth of 21.5m. At that depth the mudstone is mid-grey (it is black when fresh), and the bedding is clearly visible. The bedding is clearly visible for many metres above this but the rock is leached to a light brown colour. Lateritic weathering has been observed to a depth of 7m in another quarry. Humevale Formation mudstones tend to fret relatively rapidly when exposed to the atmosphere.

5) Topographic features which trend approximately 055° occur at 4,100m, 7000m and 9000m. These may be underlain by faults.

<u>9000m - 9,600m Interval along section line AB</u>

1) Mapping shows that sediments of the Dargile Formation occur over this interval. Lithologies should be the same as described for the 900m-3,400m interval.

2) Apparent dip should be 10° northerly along the proposed route.

3) The main joint set should be 150°/86 NE and others are 078°/68SE, 109°/86S, 162°/45SW, 180°/V, 026°/V and 055°/77 NW.

4) Weathering should be similar to that over the 900m - 3400m interval.

5) Faults are postulated at 9000m and 9,600m. The latter is the Wheelers Hill Fault (trending 140°) which is possibly a major feature in the Palaeozoic sediments.

9,600m - 13,300m Interval along section line AB

This interval is largely obscured by a veneer of up to 20m of Tertiary sediments and the following interpretation is most tenative.

1) Sediments of the Dargile Formation should occur over this interval. The southern limit of the formation is placed at 13,300m on interpretation of lithologies of cores recovered during the current Dandenong Valley Trunk Sewer drilling programme. However, these lithologies cannot be considered conclusive at isolated intersections.

2) Apparent dips along the direction of the proposed route should vary from 10° northerly at the north end of the interval to sub-horizontal at the southern end. The flat dips occur because the proposed route is more or less along the strike of a gently to moderately dipping strata.

3) No data has been obtained on jointing in this area.

4) Weathering is intense at the surface (Zone 1A) and moderate (Zone 3) weathering is still present at 56m depth in DVTS No. 8 bore - drilled by the MMBW at the intersection of Police Rd and Gladstone Rd., Dandenong.

5) No faulting other than the Wheelers Hill Fault is anticipated.

13,300m - 15,700m Interval along section line AB

Again there is a veneer of Tertiary sediments which make the following interpretation most tentative.

1) It is anticipated that sediments of the Anderson Creek Formation will occur over this interval. These are dominantly massive siltstones but massive sandstones (greywackes) may be present. Hornfels, possibly brecciated at the Yellingbo Fault, may be present.

2) No estimates of the apparent dips can be made at present.

3) No data on jointing is available.

4) The weathering profile may be deep, comparable to that

in the 9,600m - 13,300m interval.

5) The only fault anticipated is the Yellingbo Fault which tends 055° and which may be a major feature.

15,700m - 16,400m Interval along section line AB

This interval is complex and includes sedimentary and very weathered igneous (granodiorite) rocks. Brecciation is extensive at 16,000m and is probably due to the Melbourne Warp which is a major 135° trending fault in the Palaeozoic rocks. SEC drilling at Dandenong penetrated 27m of granodiorite weathered to clay without intersecting fresh rock and similar weathering can be anticipated at any occurrences along the proposed route.

16,400m - South Eastern Purification Plant

This is an interval of unconsolidated sands, sandy clays and clayey sands. Records indicate that the water table will be at approximately 5m depth.

SUMMARY OF THE GEOLOGICAL HISTORY

Following deposition of great thicknesses of sediments between the Lower Silurian and the Lower Devonian there was a major orogeny in the Middle Devonian. It is assumed, in this report, that the compressive stress which caused the orogeny was oriented north west - south east. This stress produced a major north easterly trending anticline in the north west of the project area and a broad syncline in the central and eastern part of the project area. The syncline appears to be oriented northeasterly also. Faulting may have occurred at this time as fault directions are consistent with a north westerly stress. It is suggested that the Tertiary structures (folds and faults) are underlain by Palaeozoic faults, and are in fact due to minor rejuvenation of some of these features. Sub-surface evidence of this has been seen at the Melbourne Warp. The fault directions

are:-

1) 135°-140° - the Melbourne Warp and the postulated Wheelers Hill Fault.

2) 035°-040° - the postulated Brushy Creek Fault.

3) 010° - a postulated unnamed fault zone.

4) 055° - the Yellingbo Fault - postulated in the project area although proven elsewhere.

The generalised joint pattern is also consistent with a stress from the northwest. Thus the folding, faulting and jointing can be explained as resulting either from the same northwesterly stress or from a series of stresses coming from the same northwesterly direction. It seems probable that they all occurred during the Middle Devonian orogeny.

The orogeny was followed by the Middle to Upper Devonian acid volcanics in the form of a cauldron subsidence immediately to the east of the project area in the Dandenongs; and this, in turn, by intrusion of the Lysterfield Granodiorite.

There was then a long period of weathering and erosion which would have been terminated in the Jurassic by a regional uplift, although no direct evidence of this has been located in the project area. This uplift initiated another period of erosion which, by the Middle Tertiary, had produced a subdued, deeply weathered topography referred to as the Nillumbik Terrain. In the Middle Miocene the south and south eastern part of the project area was invaded by a shallow sea, the limits of which were, in part, along what is now Wheelers Hill Fault. Marine, paralic and fresh-water sediments were deposited at this time. Following retreat of the sea there was a period of lateritisation in the Lower Pliocene resulting in red-browncolours and mottling of the clays, then there was another uplift. This initiated the current erosion cycle.

It is apparent that movements occurred along various structures at times throughout much of the Tertiary. Faulting has occurred in post-Pliocene times and has directly influenced much of the present topography including such features as the Wheelers Hill escarpment, the Croydon Sunklands, and other less prominent features. The Brushy Creek escarpment is relatively subdued in the project area and this may indicate that little or no movement occurred along it there in the Tertiary although such movement has been proven on the Yan Yean sheet to the north. However, it is probable that Middle Devonian faulting took place.

Surface geology along the route of the Proposed Dandenong Valley Trunk Sewer

INTRODUCTION

A geological study of the surface geology along the route of the proposed Dandenong Valley Trunk Sewer (DVTS) (figure 1) has been carried out at the request of the Melbourne and Metropolitan Board of Works (MMBW). A preliminary map (scale 1:25,000) was presented to the MMBW in October 1972. This showed all available data such as bore holes, many structural features (taken from the Ringwood 1:63,360 geological sheet) and the results of field investigations.

Since then, detailed studies of the topography and joint patterns have been made and new exposures have been mapped. The detailed studies have indicated various structural features and these have been incorporated onto the geological map accompanying this report (plate I).

Outcrops are sparse, particularly in the Humevale Formation, and this has led to the extensive use of topographic analysis as an aid of mapping.

TOPOGRAPHY

A dominant feature of the area is Dandenong Ck. At the northern end of the project area the creek flows more or less due west before turning to the south. It then drops gradually from an elevation of 82m near Canterbury Road to 9m near the purification plant (plate I).

Between Canterbury Rd at Vermont and Brady Rd near Rowville it is bordered on the west by a pronounced escarpment. This escarpment is oriented NE-SW between Canterbury Rd where its crest is some 45m above the creek bed, and High Street Rd where its crest is about 61m above the creek bed. From this point the escarpment suddenly changes direction to run NW-SE between Mount View Reservoir where

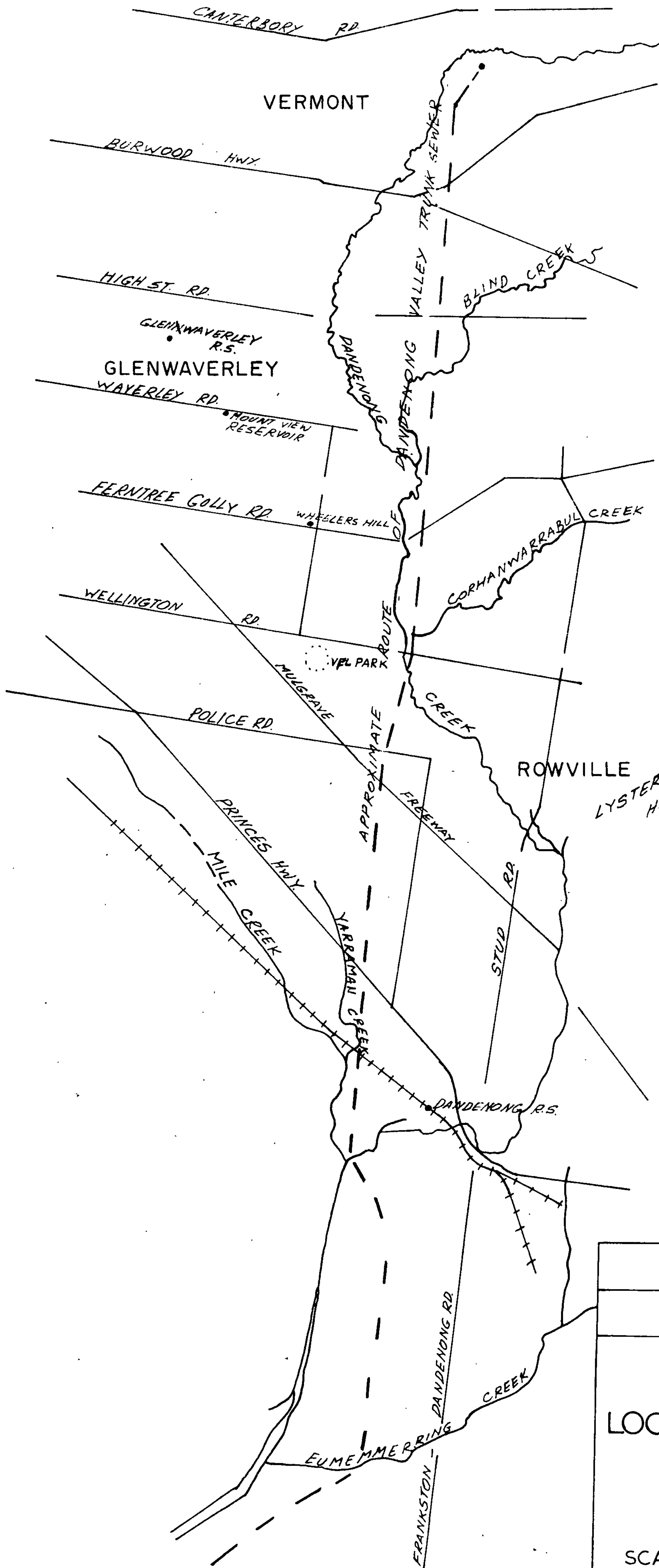


FIG. 1
LOCALITY DIAGRAM

SCALE : 1:75000

it has its maximum elevation above the creek bed of some 91m to Brady Rd where it is a much reduced feature of some 23m height. West of the escarpment the topography is that of a flattish plateau dipping gently southwest. There is however, a pronounced 4^{o} southwest tilt of the edge of the plateau between Mount View Reservoir and Wheeler's Hill.

The corresponding eastern side of Dandenong Ck has a more subdued topography. Running south west from Heathmont Railway Station there is a well defined ridge the elevation of which decreases from 130m at Wantirna to 90m at High Street Road; relative elevations on the western side of Dandenong Ck are 130m (east of Mitcham Reservoir) and 150m (near Glen Waverley) respectively. East of the ridge the terrain is flat and depressed and it rises only gradually from an elevation of 60m at Dandenong Ck to 90m at the far east of the mapped area (Plate I). This flat terrain borders Dandenong Ck between Blind and Corhanwarrabul Cks. South of the latter creek there is greater topographic relief and, south of this again, the terrain rises sharply up to the Lysterfield Hills - a prominent NE-SW feature.

The flat country between Blind Ck and Corhanwarrabul Cks, and possibly as far south as the base of Lysterfield Hills, is part of the hypothetical Croydon Senkungsfeld or Sunklands (Jutson 1911). Its depressed nature is emphasised by the extensive river flats at Bayswater and Scoresby (to the east of the mapped area).

Between Brady Rd and the Princes Highway, Dandenong Ck has a southerly course with flat terrain now on the western side, and hills to the east.

South of the Princes Highway the Creek flows due west for a short distance and then south through very flat country to Port Phillip Bay.

It can be seen from the above description that the topography has a definite pattern. A detailed analysis of the MMBW 1:4,800 contour maps (5 ft contour interval) was made to identify and define this

pattern. The analytical methods and results are discussed below.

METHODS OF ANALYSING TOPOGRAPHY

High Point Analysis

This was done by placing a 1000 ft grid over each 1:4,800 topographic sheet and recording the highest elevation within each grid square at the centre of the square. These values were then recontoured (figure 2A). This analysis removes minor detail and emphasises the major topographic features.

Slope Analysis

As slopes of a terrain are the product of the underlying geology and the various geomorphic processes the terrain has undergone, it is likely that their analysis could help identify geological structure and stratigraphy. The analytical method used was suggested by a paper by Speight (1970) who states "Frequency-distributions of landform slope angles ..... when expressed in terms of the logarithm of the slope tangent, are nearly normal (Gaussian) distributions and their standard deviations are independent of average slope".

The slope analysis discussed below was done by placing a 500 ft. grid over each 1:4,800 topographic sheet and measuring the log tan of the greatest slope within each grid square. This was plotted against the cumulative percent frequency on probability paper. This approach to the data was suggested by the treatment of log normal geochemical data by Tennant and White (1959). Plots were made for each sheet and for the area as a whole. The overall plot is shown in figure 2B. This graph shows three distinct straight line relationships and the limiting values of these were contoured (figure 2B). As the very low angles were difficult to measure, and so may be inaccurate, the various breaks in the graph at these low values were not used.

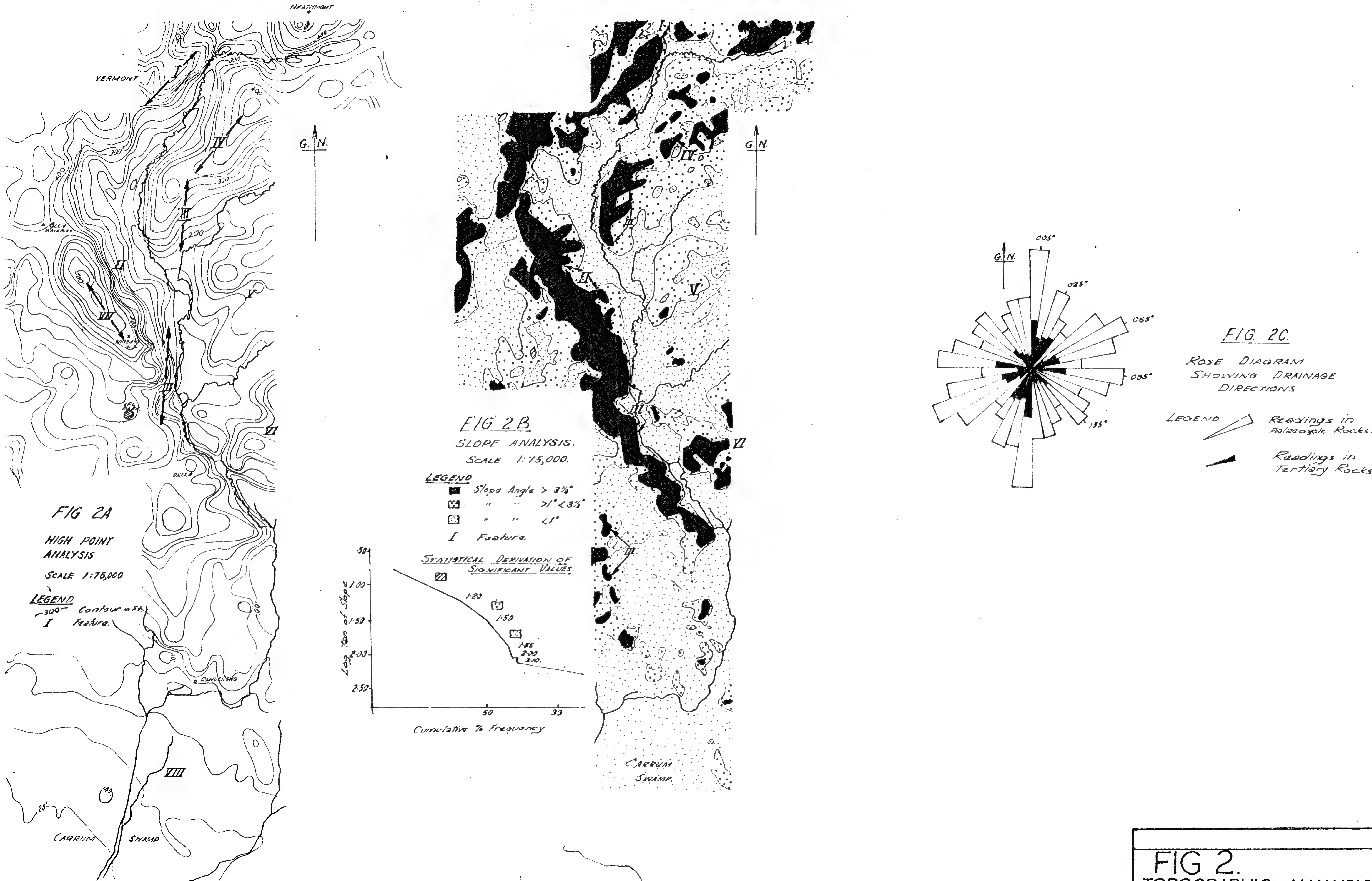


FIG 2.
TOPOGRAPHIC ANALYSIS BETWEEN VERMONT AND THE CARRUM SWAMP.

Drainage Analysis

The drainage analysis was done by measuring the bearing and length of streams and gullies using the 1:4,800 maps. The total length of drainage occurring in the various 10° sectors was plotted on a rose diagram (rather than plotting the number of occurrences). This method was used for joints by Blanchet (1957). Measurements on the broad alluvial flats of the main creeks were included. Measurements taken in drainage on Palaeozoic rocks were distinguished from those taken on Tertiary rocks - and there is close correlation between the two sets of values (figure 2C).

RESULTS OF TOPOGRAPHIC ANALYSIS

The various features brought out by these analyses are summarised in Table 1.

The analyses allow precision in location and orientation of the topographic features. There is good agreement between the slope and high point analyses but some discrepancy with drainage analysis.

Feature I is roughly on line with the Beaumaris Monocline but there may be no relationship with it.

Feature II is the Wheeler's Hill escarpment.

One of the most interesting features is Number III which runs more or less north-south. Figure 2B indicates that this feature is persistent in length. Its possible northern extension strongly modifies Feature IV and causes offsetting of Feature II.

Feature IV is a ridge of Dargile Formation sediments.

The orientation suggested in Feature V is also of interest as it is approximately parallel to that of the Lysterfield Hills. The feature itself represents the Croyden Sunkland.

The 095° trend which shows up strongly in the drainage analysis is apparent in the other analyses only along Dandenong Ck at Vermont and Dandenong.

TABLE 1

SUMMARY OF TOPOGRAPHIC ANALYSES RESULTS

NOTE:- SEE ALSO FIGURE 2.

FEATURE	ORIENTATION ACCORDING TO ANALYTICAL METHOD		DESCRIPTION	EQUIVALENT DRAINAGE DIRECTION (FIGURE 2C)
	HIGH POINT (FIGURE 2A)	SLOPE (FIGURE 2B)		
I	042°	040°	Prominent escarpment	? 025°
II	150° changes to 143° at S end	140°	The Wheelers Hill Escarpment	135
III	185°	181°	Short escarpment with possible "extensions" north and south. These "extensions" are expressed respectively by the change in the trend of a ridge, and the trend of a creek.	185°
IV	035°	040°	Prominent ridge	? 025
V	050	045°	Flat area with gentle rises (Croydon Sunklands)	?, 065°
VI	present	present	Hilly area - no apparent orientation	not apparent
VII	150°	not apparent	Prominent SW tilt to the edge of the plateau.	not apparent
VIII	present	not apparent	Very flat area dipping gently south westerly (Carrum Swamp)	
	-	present	Definite drainage feature	095°

GEOLOGY

STRATIGRAPHY

The project area is underlain by lower Palaeozoic and Tertiary rocks. There are also extensive developments of Recent clays, sandy clays and clayey sands. In places, the Palaeozoic rocks are weathered to clay.

Igneous rocks are represented by a small batholith, two small circular to elliptical plugs and several thin (1'-3') dykes. All these intrusions are acidic.

The formations are described in the Explanatory Notes on the Ringwood 1:63,360 Geological Map (Vandenberg 1971), and the brief resume below is largely taken from those notes as are the quotes

PALAEOZOIC ROCKS

"The Anderson Creek Formation consists almost entirely of massive mudstones and minor siltstones. Bed thicknesses range from a few cm to about a metre; 15 to 30 cm in claystones to silty claystones. They show a great abundance of worm burrows parallel to the bedding. When fresh, the mudstones are dark grey and the burrows black. The mudstones are invariably interbedded with thin to very thin sandstones, ranging between 3 and 12mm, which show prominent current bedding, sometimes also laminations .... Thick repetitive turbidite sequences are found at numerous intervals in the Anderson Creek Formation. Bed thicknesses range from a few cm to more than 3m; 15 to 60 cm is most common"(photo. 1). Vandenberg also mentions greywackes (sandstones containing rock fragments) (photo. 2) and conglomerates in this formation. Garratt (personal comm.) reports that arenaceous (sandstone) beds occur towards the top of the formation.

The formation crops out in the north western part of the project area. Massive 0.3-1m siltstones can be seen in cuttings in Springvale Rd. and Burwood Rd west of Dandenong Ck. Massive arenaceous beds (up to 3m thick) occur at Vermont and in a low cutting in Canterbury Rd just west of Wantirna Rd. The rocks are generally

weathered to Zone 2-3 stage (See appendix I).

No outcrops of the formation occur along the proposed route. Vandenberg (1971) records an estimated thickness of 2,300+m.

The contact between the Anderson Creek Formation and the Dargile Formation is a gradational one.

"The Dargile Formation consists of rhythmically interbedded thin mudstone, siltstones, shales and sandstones. Bed thicknesses vary between 12mm and 30cm; 25mm to 50mm is most common ..... The argillites form the largest component of the formation, i.e. approx. 75 to 80% of the total thickness". "....Estimated thickness: 1,700cm" (photo 2).

Whilst this description fits many of the outcrops of Dargile Sediments in the project area it should be noted that siltstone beds up to 1m thick are common in certain areas (e.g. along Wellington Rd just E of Dandenong Ck), and at the cutting in High Street Rd near Norton's Lane some siltstone beds are 4-5m thick. The rocks are generally weathered to Zone 1B-2 stage.

The only outcrop along the proposed route is on the Burwood Highway east of the Mountain Highway. Here, light brown and pinkish interbedded sandstones and siltstones strike 026° and dip 70°-80°D. The beds are 0.1-1m thick. Similar lithologies occur at other outcrops adjacent to the proposed route in Wantirna Rd, High Street Rd, and Wellington Rd. The degree of weathering varies from outcrop to outcrop.

The Dargile Formation forms the "spine" of a ridge which runs SW from the Heathmont Railway Station to the Dandenong Ck-Blind Ck Junction (Feature IV - Figure 2). The existence of this ridge is probably due in part, to differential weathering as the more arenaceous Dargile sediments are probably more resistant than the dominantly argillaceous Humevale sediments. However, Garratt (in press) believes it is bounded on the east by a continuation of the Brushy Creek Fault (Jutson 1911). Thus the eastern side

of the ridge may be a much subdued fault scarp modified by differential erosion. The contrasting prominence of the escarpment along the Brushy Creek Fault to the north is possibly due to greater displacement there during the Tertiary whereas, in the project area, little or no displacement may have occurred at that time. This is assuming that the fault is a Palaeozoic feature reactivated at various times throughout its history.

The sediments of the Dargile Formation and the Humevale Formation are generally readily distinguished. However, the actual contact of the formations is usually obscured and there are indications, in certain areas, that there is a tectonic disconformity (Garratt pers. comm.)

"The Humevale Formation includes a variety of rock types. In the Kilsyth-Bayswater area, massive siltstone predominate, which characteristically contain small flakes of mica. Beds are often in excess of 3m thick, and, where present, bedding is difficult to detect ..... In the eastern part of the area, sequences of thick, massive siltstones alternate with sequences of rhythmically interbedded mudstones and thin greywackes. Estimated thickness: 4300m+" (photo 4). In the project area the formation crops out as a light brown siltstone (Zone 2-3) which weathers to starchy fragments (photo 5). In fresher exposures it is black (Zone 4). Bed thicknesses are 1m or less.

At City Brick Works Co. Pty. Ltd. quarry south of High Street Rd, just west of the proposed route, highly jointed mudstone beds up to 1m thick with very thin siltstone interbedded strike 017° and dip 33°E. A similar exposure which is richly fossiliferous occurs at the company's factory to the east of the quarry. This locality is along the proposed route.

The Lysterfield Granodiorite is a medium grained biotite granodiorite which crops out at, and east of, Dandenong. It is frequently very weathered (photo 6). It intruded Humevale Formation sediments producing a metamorphic aureole of hornfels. This hornfels forms the prominent Lysterfield Hills.

The Tally Ho Quartz Diorite occurs as a small plug of quartz diorite just south of the junction of Springvale Rd with Highbury Rd.

Other Intrusions occur in the project area. Thin dykes weathered to clay, crop out in Stud Rd just north of Brady Rd. A weathered porphyritic dyke was exposed in a trench between Lums Rd and Jells Rd south of Fern Tree Gully Rd. Similar weathered porphyritic material occurs as what appears to be a very small plug just south west of the Stud Road - Wellington Rd intersection.

TERTIARY ROCKS

Tertiary sediments do not crop out north or east of the Wheelers Hill escarpment and their occurrence is much reduced north of a north west line between Glen Waverley and Balwyn (see the Ringwood Geol. Sheet).

The Newport Formation consists of dark grey-green and green glauconitic silt. These marine sediments do not crop out in the project area but have been intersected in bores in the Carrum Swamp area. The sediments are of Miocene age. Their approximate northern limit is the Melbourne Warp (Plate I).

The Red Bluff Sands consist of poorly consolidated grits, sands, clayey sands and sandy clays which were deposited under near shore and/or fluviatile conditions in the Pliocene. In the project area they are probably no more than 30m thick. Contact with underlying rocks is frequently very irregular with scours several feet deep being common.

PLEISTOCENE TO RECENT DEPOSITS

These occur in valleys and alluvial flats and in the Carrum Swamp. They are unconsolidated sands, clays, sandy clays and clayey sands. Lithologically they are very similar to Red Bluff Sands sediments although the latter are usually better consolidated. In several areas - particularly south of the Melbourne - Dandenong railway line - distinction between Tertiary formations and younger sediments is uncertain. According to

drill records the alluvial deposits can be quite thick. A thickness of 22m of clay, sandy clay and gritty clay is recorded in a bore in Blind Ck near its junction with Dandenong Ck (Mines Department Reference bore 30, Parish of Scoresby); and a Country Roads Board bore penetrated 35m of sand and clay overlying granodiorite in the Dandenong Ck where it is crossed by the Mulgrave Freeway (CRB reference Dandenong No. 1).

UNDIFFERENTIATED CLAY

Scattered exposures of mottled clays occur near the base of the Wheeler's Hill escarpment between Shepherd Rd, Glen Waverley, and Fern Tree Gully Rd. The clay seems to be too high up the hill slope for it to be alluvial and it may be either lateritised Humevale Formation sediments or related to the Wheelers Hill Fault.

PALAEONTOLOGY

Although what appear to be fossil fragments are not uncommon in the project area, there are only two known fossil localities that can be used for stratigraphic purposes. These are at the intersection of Wellington Rd and Stud Rd, and at the City Brick Works Co. Pty. Ltd. factory west of Cathies Lane. The latter locality was located during the current mapping. M. J. Garratt has since collected fossils (see appendix II) at this site and has been able to give it the tentative stratigraphic position of 500m above the base of the Humevale Formation. If this is so, then the mapping (Plate 1) indicates faulting out of some (possibly 100m) Humevale Formation sediments between the fossil site and the ridge of Dargile Formation sediments to the west. On the cross section (Plate II) it is suggested that this possible faulting occurred at the postulated Brushy Ck Fault.

Garratt has recently collected trilobite and orthocerid fragments from the quarry on Blind Ck west of Cathies Lane.

STRUCTURE

TECTONIC HISTORY OF THE REGION

The structural framework of the region is presented on the Ringwood 1:63,360 Geological Sheet and in Figure 1 of its explanatory notes. Some modifications and additions are suggested in this report (Plate I). The various regional structural features are best described relevant to the tectonic history and the following is a summary taken largely from Neilson (1970) and Vandenberg (1971).

1) In the Middle Devonian very strong folding occurred producing a series of anticlinoria and broad synclines in the Silurian and Devonian sediments. These folds occur mainly in the western half of the region (i.e. west of Dandenong Ck). Fold axes, which are generally oriented NNE in the west, trend NE near Dandenong Ck. Corresponding inferred major stress directions are WNW and NW respectively. Although no associated major Middle Devonian faulting has been observed in outcrop, the extensive brecciation of Silurian rocks exposed by MMBW tunneling through the Melbourne Warp is interpreted in this report as being contemporaneous with the folding.

2) In the Middle to Upper Devonian there was cauldron subsidence which affected much of the region east of the project area. In part, this subsidence occurred along the Yellingbo Fault (Vandenberg 1971), which is a major feature bearing 055°. This fault appears to continue into the project area. The fault is possibly older than the subsidence and, as discussed later in this report, it may have been established during the Middle Devonian Folding.

3) Various intrusions occurred in the Upper Devonian. The largest of these was the Lysterfield Granodiorite which crops out in the project area. This intrusion is, in part, bounded by the Yellingbo Fault.

4) The subsequent long period of erosion was interrupted by uplift and warping during the Jurassic. However, no feature attributable to this uplift has been identified in the project area.

5) The Jurassic uplift was followed by another long period of relative stability during which there was prolonged erosion to a low relief, invasion by a shallow sea, deposition of sediments and lateritic weathering. In the Miocene there was another regional uplift and movement occurred along the Melbourne Warp and possibly the Beaumaris Monocline, Wheelers Hill Fault and Mitcham Axis.

Various relatively minor movements probably occurred at times other than those described above e.g. extrusion of the Older and Newer Volcanics may have been accompanied by some slight regional tectonism. Vandenberg (1971) dates movement on the Wheeler's Hill Fault as post-Pliocene.

JOINTING IN THE PROJECT AREA

Results of a detailed joint study made in the project area are shown in Figure 3. Measurements were taken along road cuttings and in quarries. Bedding plane joints were difficult to identify and were not recorded. The dominant joint direction observed at each exposure was plotted and readings from exposures exhibited similar directions of dominant jointing were combined to produce diagrams showing joint patterns representative of particular areas (Fig. 3B). In addition, all readings were combined in Figure 3A. The orientations and relative frequencies (pole % age) are tabulated on Figure 3.

Various factors are apparent from the Figures, namely:

1) The statistically most common joint direction trends north westerly.
2) Joints are generally vertical north of High St Rd and south of Corhanwarrabul Ck.
3) The proposed route of the tunnel north of High St Rd and south of Corhanwarrabul Ck. is roughly parallel to a persistent joint direction. The other joint directions intersect the line of the route at between 45° and 90°.

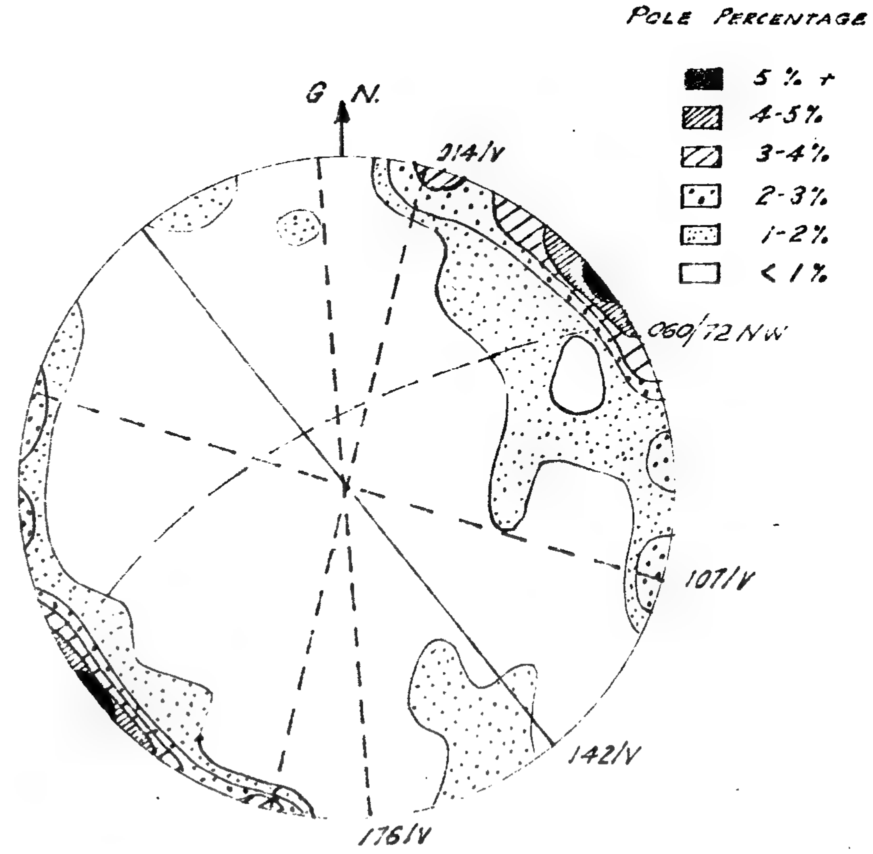


FIG. 3A EQUAL AREA LOWER HEMISPHERE STEREOGRAPHIC PLOT OF POLES OF ALL JOINT READINGS.

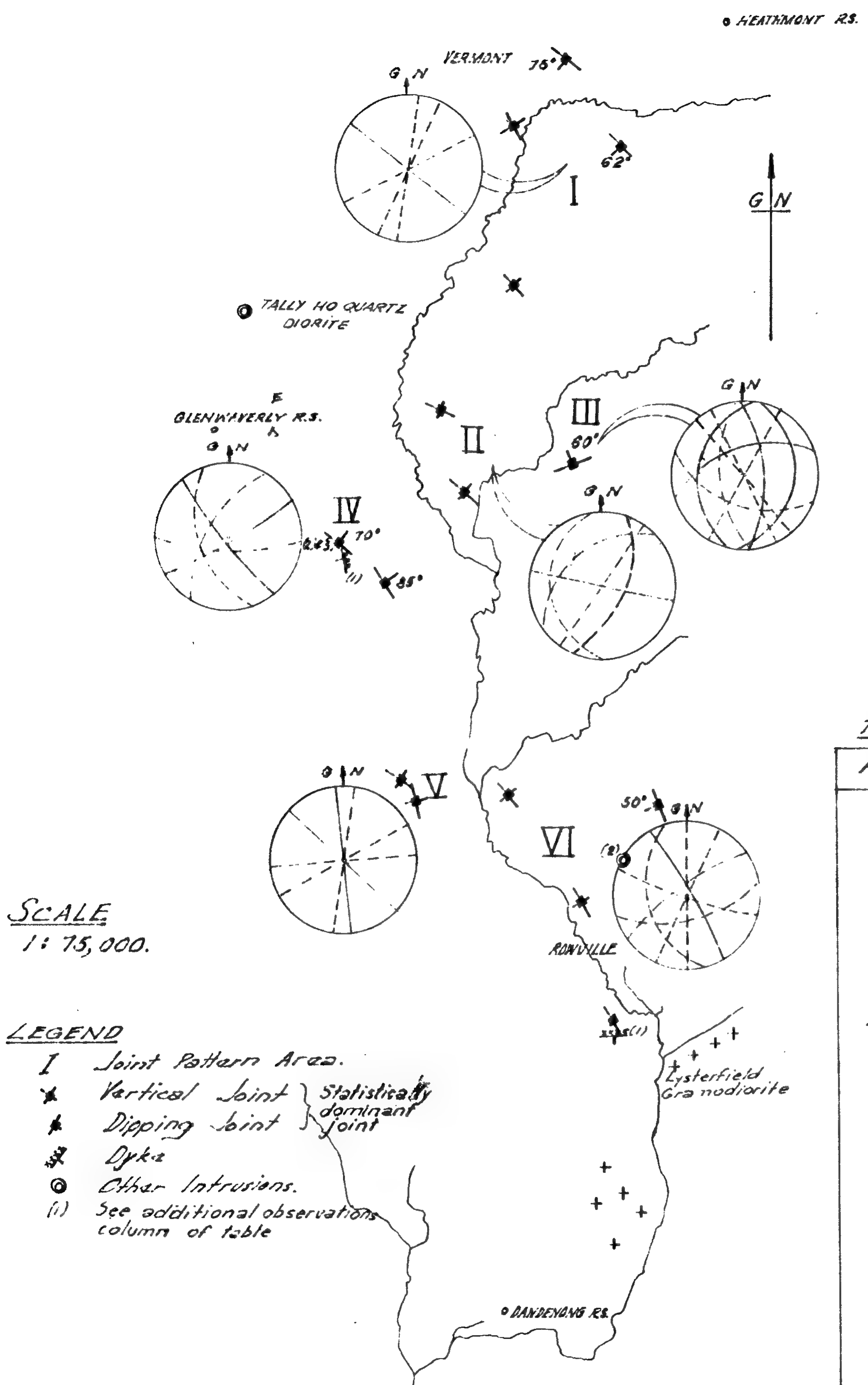


FIG. 3B STEREOGRAPHIC DIAGRAMS SHOWING JOINT PLANES OCCURRING IN AREAS OF SIMILAR JOINT PATTERN.

NOTE The joint planes shown are representative of concentrations of joint poles. The contours of these concentrations were omitted in order to simplify the above presentations.

TABLE SHOWING DETAILS OF JOINTS.

AREA	STRIKE/Dip Joint Plane	POLE % age	No. of READINGS	ADDITIONAL OBSERVATIONS.
I	138/V 012/V 028/V 064/V	13 2 2 2	260	
II	103/V 021/62E 035/V 054/46NW 170/29SW	6 2 2 2 2	270	
III	010/40W 012/33E 071/60NW 174/70E 122/54S 153/V 174/75W 028/V 139/V	6 6 6 6 5 4 4 3 3	132	
IV	060/87SE 142/83SW 161/56SW 032/65NW 090/75S	7 7 4 3 2	215	(1) Porphyritic Dyke 174°/72°W (2) Quartz stringers strike from 092°-130° (3) ½" thick quartz filled tension gashes str 137°
V	173/V 131/V 188/V 060/V 085/V	12 11 8 5 3	162	
VI	150/86NE 078/68SE 109/86S 162/46SW 180/V 026/V 055/77NW	8 4 4 3 2 2 2	444	(1) Very weathered dyke 077/80S. (2) Small porphyritic intrusion str 090°?

FIG 3.
JOINT ANALYSIS BETWEEN VERMONT & ROWVILLE.

4) Joints between High St Rd and Corhanwarrabul Ck are usually dipping joints and the NW trend is largely obscured. However, there are only three outcrops in this area and they may not be very representative.

5) The orientation of the joints particularly in Figure 3A is consistent with them being produced by the same stress, or by stress from the same direction, as that which produced the Middle Devonian folding. This point is discussed below:-

As fold axes between Canterbury Road and Burwood Highway are oriented approximately 045° (Plate I), the direction of maximum stress is approximately 315° (135°). Thus the 142° jointing can be interpreted as a tension failure and the 107° as a shear failure. The directions of 356° (176°) and 014° can be considered as incorporating a spread of shear joints complimentary with the 107° set, and the 060° direction as being a frictional shear parallel to the fold axis. Such an interpretation of jointing relative to stress direction is compatible with de Sitter's descriptions of very gently folded competent layers. However, stronger folding should involve jointing due to the folding itself and to release tension jointing (de Sitter 1956 pp 142-133). Thus the theoretical joint pattern expected for the strongly folded Silurian-Devonian sediments would be much more complex than that of Figure 3A. A possible explanation of this anomaly is that the initial joint pattern established at the commencement of folding statistically dominates the other joints developed as the folding intensified, particularly when the readings from many different outcrops are combined.

There are other explanations. For instance, Guerin (1971) found a similar arrangement of joints with respect to the principal stress direction in the Doncaster area. However, she also found that the readings, when plotted on a rose diagram, conform to the theoretical pattern associated with anticlinal folding and interpreted her results accordingly. Nevertheless, it is felt that the

results in the project area (Fig. 3A) are representative of the whole area rather than only of the anticlines.

It is also possible that the joints from too wide an area have been combined in Figure 3A and that the results are fortuitous.

FOLDING IN THE PROJECT AREA

Two major Palaeozoic folds occur in the project area. One of the folds is an anticline which crops out in the NW of the project area (Plate I). It is probably continuous between Burwood Highway and Boronia Road because:

1) Anticlines which have been mapped in the field at these localities are on strike (045°).

2) Topographic Feature I (Figs. 2A & 2B) which strikes approximately 040° is continuous and this suggests continuity of the underlying geology (i.e. the anticline).

The other major Palaeozoic fold is a broad syncline. However, the lack of outcrops and the presence of modifying elements such as the postulated Wheelers Hill Fault, the postulated Brushy Creek Fault, and the intrusion of the Lysterfield Granodiorite and other bodies, and the possible presence of N-S and NE-SW faulting preclude the accurate description of the feature. This structure appears to continue south of the Wheelers Hill Escarpment where the Palaeozoic rocks are covered by Tertiary sediments and their structure is completely obscured.

Various other folds of apparently local extent are shown on Plate I. Some of these may be related to the Middle Devonian Faulting.

The Beaumaris Monocline and the Melbourne Warp are monoclinal folds of Tertiary age which appear to overlie older structures.

FAULTING IN THE PROJECT AREA

As with the folding, there were at least two periods of faulting namely Palaeozoic and Tertiary. All the Tertiary movements appear to have occurred along old Palaeozoic fault planes. However, Tertiary movements probably did not take place along all the old faults or along the full length of those old faults on which they did occur.

Direct evidence of faulting is provided at several outcrops and by the MMBW drilling. This evidence is:

1) At an exposure in a road cutting on Wellington Road at VFL Park where there is a 20 metre wide very distributed zone in Dargile Formation sediments. Bedding at this locality dips 20° - 30°E but within the zone dips are up to 80°E. The exposure is a high angle easterly dipping fault. It appears to strike at 011°. This is a similar orientation to the bedding which is 024° west of the fault and 355° east of the fault. Associated with this main fault is a low angle (016°E) normal fault striking at 178°. The fault zone is within Topographic Feature III (figs. 2A & 2B) and so may be part of a zone of faulting trending approximately 010°. It is a Palaeozoic fault zone possibly with minor Tertiary movement which produced the topographic feature. However, no Tertiary movement is apparent at the exposure.

2) At an exposure in a road cutting on High Street Rd between Dandenong Ck and Cathies Lane, a number of normal and reverse faults can be seen in Dargile Formation sediments. Both types of faults occur as high angle (65°-75°) and low angle (0°-15°) easterly dipping features. In most cases displacement appears to be in the order of a couple of metres but there is a high angle reverse fault which has the typical Dargile interbedded siltstone-sandstone sequence on the east with a massive siltstone on the west of the fault plane. Displacement here is unknown but it could be considerable. Strike of this fault is 025° whilst that of the bedding is 024°. This fault zone is within an apparent northern extension of topographic

Feature III (Figs. 2A & 2B) and so it may be part of a zone of 010° faulting. However, the outcrop is quite near the postulated Brushy Creek fault amd may be related to it. Again the fault zone is apparently a Palaeozoic one with possible minor Tertiary movement. However, there is no apparent evidence of younger faulting at the road cutting.

3) Evidence of faulting can be seen in the City Brick Works Pty. Ltd. quarry just west of Blind Ck. At this quarry Humevale Formation sediments are highly jointed and the joint planes exhibit plumrose and conchoidal patterns, and occasional coarse grooving; slickensiding and minor crushing is also present. No definite age can be given to the fracturing although again it is probably a Palaeozoic phenomenon.

4) Subsurface evidence of extensive faulting in Palaeozoic sediments has been detected by the MMBW drilling along the DVTS route at the <u>Melbourne Warp</u>. (J. B. Coulsell pers. comm.). The Palaeozoic rocks are extensively brecciated and there is highly weathered granodiorite in one bore (R. A. Sanders pers. comm.). Brecciation, gouge, and very weathered thick acidic (?) dykes were encountered over several hundred feet in the Palaeozoic sediments at the Melbourne Warp in the South Eastern Trunk Sewer tunnel (R. A. Sanders pers. comm.). This evidence strongly indicates that the Melbourne Warp, which is a gentle Tertiary monocline, is a reactivated older zone of extensive brecciation and intrusion, and that this zone still exists at Dandenong. The strike of the zone is 135° which is approximately the direction of major stress during the Middle Devonian folding. Accordingly the age of the brecciation is probably Middle Devonian.

The existence of the other faults shown on Plates I & II is based on indirect evidence which is discussed below in paragraphs 5, 6 and 7:

5) <u>Wheelers Hill Fault</u> is suggested by:

(a) the topography, including the pronounced escarpment trending 140° (feature II of Figures 2A and 2B) and to a lesser extent the 135°

drainage direction (Fig. 2C). The pronounced SW tilt to the edge of the escarpment between Mount View Reservoir and Wheelers Hill is also consistent with faulting.

(b) the dominant NW direction of jointing (Figure 3) which is here considered to reflect the fault direction.

(c) the compatability of such a fault with the structural framework.

Vandenberg (1971) considers the fault to be a Tertiary feature with its maximum throw of 45 metres occurring in the Glen Waverley area. However, it is probable that this Tertiary movement took place along a fracture zone already established in the underlying Silurian-Devonian sediments during the Palaeozoic. The older feature would be more or less parallel with the brecciation underlying the Melbourne Warp and, if so, is possibly a major regional feature. This is further suggested by the linear nature of the northern edge of the Tertiary outcrop between Glen Waverley and Surrey Hills (Ringwood 1:63,360 Geol. Sheet) - which is more or less on strike with the Wheelers Hill Fault. Also, one of the ill-defined zones of pitch change (Whiting 1967) is approximately coincident with the strike of the postulated fault. It should be noted that the trend of one of the Bouguer anomalies defined during a Bureau of Mineral Resources gravity survey (Gunson and Williams, 1965) suggests a north westerly influence in the general area of the postulated Wheeler's Hill Fault and Melbourne Warp. However, the interpretation in this area is based on only a few widely spaced readings.

The postulated Wheelers Hill Fault is oriented approximately 140° and is probably offset along a N-S zone (Feature III Figs. 2A & 2B) between Fern Tree Gully Rd and Corhanwarrabul Ck.

6) The existence of faulting trending 055° which is indicated by the outcrop pattern. For example, the Yellingbo Fault which has been proven east of the Dandenong Ranges and which Vandenberg (1971) suggests continues into the project area. The sharp linear nature of the contact between the

Lysterfield Granodiorite and the hornfels of the Lysterfield Hills which is directly on strike with the proven fault is evidence of its continuation. This fault direction of 055° is repeated at Corhanwarrabul and Blind Cks and at a small intervening creek. It should be noted that these lineations, (Plate I) if projected towards the Dandenong Ranges, are coincident with pronounced "steps" in the outcrop pattern of the Mount Dandenong Volcanics Group (Ringwood 1:63,360 Geol. Sheet). The possible fault along Corhanwarrabul Ck has been incorporated into the geological cross section (Plate II). The direction of 055° is weakly brought out in Figures 2A and 2B and more definitely by the strong 065° drainage direction (Fig. 2C).

7) Garratt has mapped the Brushy Creek Fault (Jutson 1911) on the Yan Yean 1:63,360 Geological sheet and suggests its continuation to the South. (Garratt in press). Its location in the project area is shown on Plate I. The existence of the fault is supported by the mapping which indicates a loss of 300 - 400 m of Dargile sediments along the ridge SW from Heathmont - assuming the formation thickness to be 1700 m as quoted by Vandenberg (1971).

ORIGIN OF THE FAULTS AND JOINTS

If the Tertiary structural features are considered to be underlain by Palaeozoic structural features and the direction of maximum stress is deduced from the Middle Devonian folding as coming from the NW the basic structural pattern can be interpreted as an integrated one.

The directions of known and postulated faults occurring in the project area are:

1a) The fault underlying the Melbourne Warp. This fault trends 135°.

1b) The postulated fault underlying Wheelers Hill Fault. This fault trends 140°.

2) The postulated Brushy Creek Fault which trends between 035° and 040° i.e. more or less parallel to the bedding.

3) Two faults which occur in outcrop (Plate I) and which appear to be in a postulated zone trending 010°. This trend is deduced from the topography (Fig. 2), and the measured strikes at the

outcrops.

4) The postulated Yellingbo Fault (trending 055^{o}) and possible faults parallel to it at Corhanwarrabul and Blind Cks and at Fern Tree Gully Road.

These features are plotted onto a stereographic projection in Figure 4. The inferred Middle Devonian Stress direction is also shown. Inspection of this diagram indicates:

1) The faulting was contemporaneous with the Middle Devonian folding.
2) The Melbourne Warp and Wheelers Hill fault directions are ones of tensional failure.
3) The other fault directions appear to be ones of shear failure.
4) Many of the fault directions are approximately parallel to the joint directions (Fig. 4). This is contrary to the general case where joints and faults are rarely parallel (Hancock 1968).

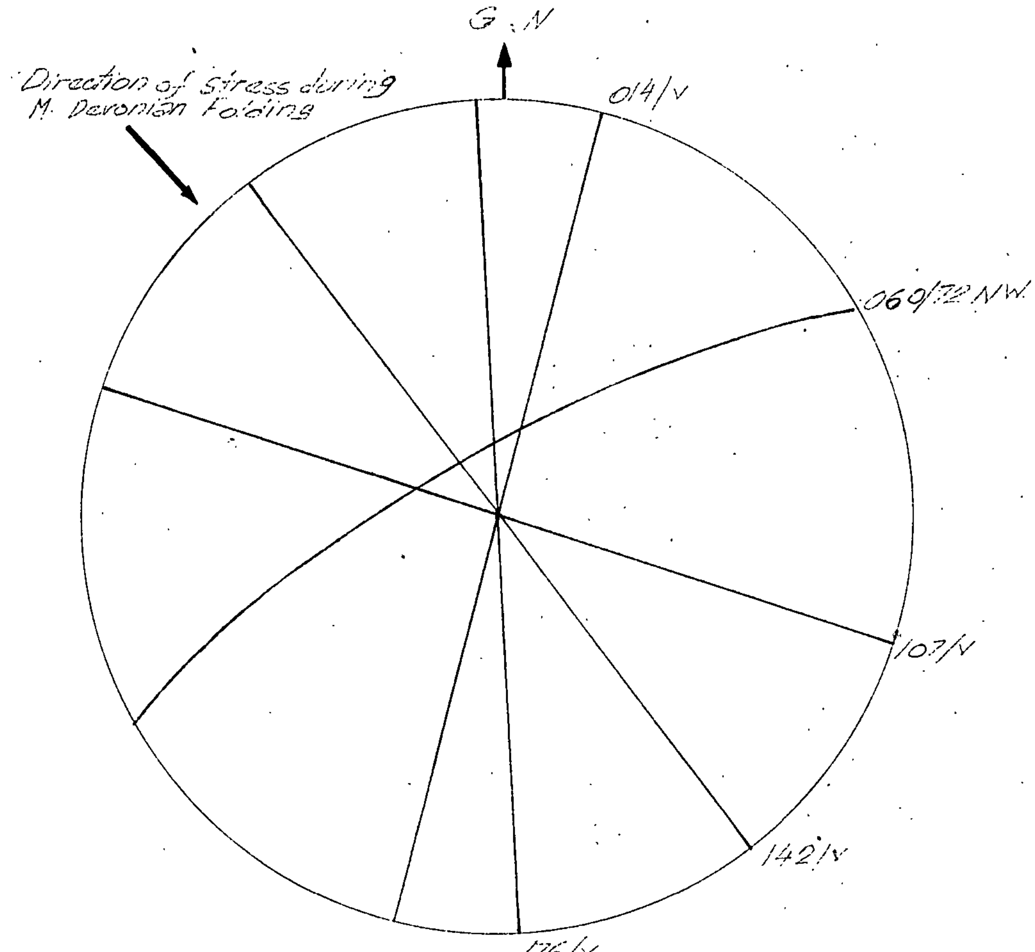
The joint analysis (Fig. 3A) indicates that there were influences other than the folding stress in the east of the project area. These may have been intrusion of the granodiorite and/or the cauldron subsidence.

Thus the basic fault structures of the project area appear to have been established in the Middle to Upper Devonian and subsequent tectonism was accommodated by movement along them. Some of these movements have occurred in geologically recent times (e.g. Wheelers Hill Fault).

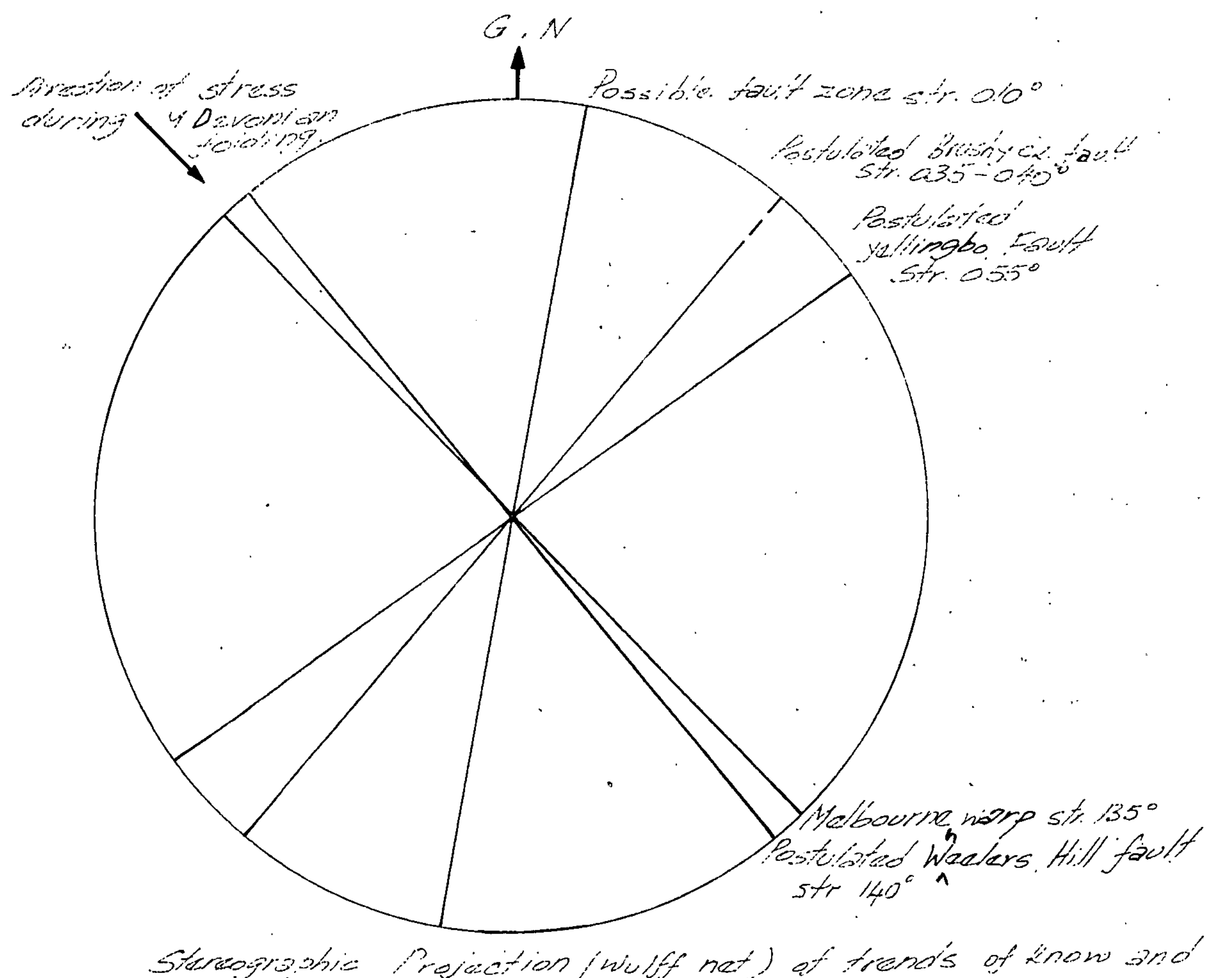
METAMORPHISM

Thermal metamorphism of the Palaeozoic sediments adjacent to the Lysterfield Granodiorite has produced an aureole of hornfels up to 750 metres wide in the Lysterfield Hills. If the contact between the intrusion and the sediments is projected to the SW it intersects the proposed route of the DVTS at, or near, the Melbourne Warp. Drilling by the MMBW has located possible hornfels at this locality (J. B. Coulsell pers. comm.). This is the only locality along the

Fig. 4 COMPARISON OF FAULTS AND STATISTICALLY MAJOR JOINT TRENDS IN THE PROJECT AREA



Stereographic projection (wulff net) of Joint planes. constructed from observations taken throughout project area



Stereographic Projection (wulff net) of trends of know and postulated and possible faults in the project area.

proposed sewer where hornfels might occur.

WEATHERING

Rocks in the project area have had the same history of intense weathering as that described by Neilson (1970) for the general Melbourne area. Although the effect of this weathering is quite variable, the following fourfold division of weathered outcrops seems valid.

1) The most intensely weathered rock is the Lysterfield Granodiorite which crops out near Dandenong as clay (Photo 6). Such intense weathering (Zone 1A) can occur to appreciable depths. For example, test drilling for the foundations of the SEC Dandenong office block penetrated 16.7m of clayey material and 10.6m of weathered granodiorite without encountering any fresh rock. One of the bores in the current MMBW drilling for the DVTS had a similar intersection near the Dandenong-Melbourne Railway line. Less advanced weathering can be seen in the bed of the Dandenong Ck west of Hammond Rd. Here the rock is still obviously granodiorite but it has weathered to the extent that shallow holes can be dug in it relatively easily with a geological pick (Zone 2).

2) Very deep weathering occurs in the Palaeozoic rocks overlain by, or recently exposed from the veneer of Tertiary sediments. In the project area such rocks are exclusively Dargile Formation sediments. Examples can be seen at road cuttings in Wellington Rd outside VFL Park, and in Fern Tree Gully Rd east of Jells Rd. At these outcrops Tertiary sandstone overlies 3-4m of Dargile Formation sediments completely weathered to a white silty clay (Zone 1A) and this grades downwards into sequences of leached interbedded white, soft siltstone and sandstone. An indication of the depth of weathering which occurs under these conditions is given by a MMBW drill hole sunk at the intersection of Police Rd and Gladstone Rd., Dandenong. This bore (DVTS No. 8) had a total depth of 61m and Zone 3 weathering was present at 56m depth. The weathering profile in these areas is that of the Nillumbik Terrain (Hills 1934) which has been preserved beneath the protective veneer of Tertiary sediments. Elsewhere in the project area the Nillumbik Terrain profile has been partly stripped off by erosion particularly since the last uplift which occurred at the end of the Pliocene.

3) Mottled clays and ferruginised sandstones produced during the Lower Pliocene lateritic weathering crop out in parts of the area. These include lateritised Tertiary rocks, for example those exposed along the Mulgrave Freeway; and lateritised Humevale Formation mudstone, for example those in quarries off Cathies Lane, Scoresby (Plate I). In the quarry on the west side of Blind Ck there is 7m of mottled clay (Zone 1A) overlying 7m of light brown mudstone (Zone 2-3) which grades to black (Zone 4-5) over the basal metre. In the quarry on the east side of Cathies Lane 3.5m of mottled clay (Zone 1A) overlies 18m of mudstone which grades from light brown at the surface to dark grey (Zone 2-4) at the base. These are the only exposures of lateritised Palaeozoic rocks observed in the area and both of them occur in the hypothetical Croydon Sunkland.

Scattered exposures of mottled clay occur near the base of the Wheeler's Hill escarpment between Shepherd Rd, Glen Waverley and Fern Tree Gully Rd. The origin of this clay is unknown but it may be related to the fault.

The Humevale Formation mudstones weather to starchy fragments (photo 5) when exposed to the atmosphere. Vandenberg (pers. comm.) points out that such weathering is frequently rapid and that relatively fresh rock is reduced to clay within a few years.

4) In those areas where the Nillumbik Terrain and the lateritic weathering profile have been extensively eroded the Palaeozoic sediments generally crop out in road cuttings as moderately hard sandstones and siltstones coloured pink, light brown, pale yellow, light grey and white (Zone 2-3). However, some of the siltstone beds in the interbedded siltstone-sandstone sequences of the Dargile Formation, which have been exposed in road cuttings in Wantirna Rd north of Boronia Rd and High Street Rd near Nortons Lane, are more highly weathered (Zone 1). At the latter locality there are a number of faults and it is possible that the siltstone was crushed or sheared during the faulting (Photo 3). There are no deep exposures or drill holes to give an indication of the depth of weathering.

REFERENCES

Blanchet, P. H., 1957: Development of fracture analysis as exploration method. Bull. Amer. Ass. Petrol. Geol., 41, No. 8. pp. 1748-1759.

de Sitter, L. U., 1956: Structural Geology. McGraw-Hill Publishing Co. Ltd.

Garratt, M. J., in press: Faulting and physiography of the Croydon Sunkland, Vic.

Guerin, B. J., 1971: Preliminary report on the engineering geology of the Doncaster area. For Railway Construction Board, Geol. Surv. Vict., unpublished report.

Gunson, S., and Williams, L. W., 1965: Gravity Surveys of Port Phillip Bay and Adjacent Areas, Victoria 1957-1958. Bur. Min. Resour. Aust. Rec. 1965/64.

Hancock, P. L., 1968: Joints and faults. Proc. Geol. Ass., Vol. 79, Part 2. pp. 141-151.

Hills, E. S., 1934: Some fundamental concepts in Victorian physiography. Proc. Roy. Soc. Vict., 47(1) pp. 158-174.

Jutson, J. T., 1911: A contribution to the physiography of the Yarra River and Dandenong Creek basins, Victoria. ibid., 23(2) pp. 469-515.

Neilson, J. L., 1970. Notes on weathering of the Silurian rocks in the Melbourne district. J. Inst. Eng. Aust., 42(1-2), pp. 9-12.

Speight, J. G., 1971: Log-normality of slope distributions. Z. Geomorph. 15, pp. 290-311.

Tennant, C. B. and White, J. L. 1959: Study of the distribution of some geochemical data. Econ. Geology 54, pp. 1281-1290.

Vandenberg, A. H. M., 1971: Ringwood 1:63,360 Geological map and explanatory notes. Geol. Surv. Vict., Report number 1971/1.

Whiting, R. G., 1967: Silurian, structure and stratigraphy; <u>in</u> Geology of the Melbourne District, Victoria. Bull. Geol. Surv. Vict., 59 pp 19-23.

APPENDICES I & II

APPENDIX I

Weathering Zone in Melbourne Silurian Mudstone

Zone Number	Degree of Weathering	Material Type	Typical Colour†	Mohs' Hardness	Reaction to Blow from 2-lb. Hammer	Visibility of Bedding	Soil or Rock*
1A	Complete	Silty clay or sandy clay (usually stiff to hard)	Yellow-brown	Max. 0.5	—	Bedding indiscernible	Soil
1B		Silty clay or sandy clay containing harder rock fragments					
2	High	Soft mudstone, with clay seams common. Clay is often from decomposition of mudstone beds; often it is in joints, with iron oxide also. Strength low.	Yellow-brown	0.5-1.0	Shatters easily with light blow		
3	Moderate	Moderately hard mudstone. Thin mudstone bands weathered to clay are known, but uncommon. Joints sometimes carry thin clay deposits, or often iron oxide. Strength moderate.	Pale brown and pale grey mottled	1.0-1.5	Only fractures with light blow. Shatters with fairly heavy blow.	Bedding mostly discernible.	Rock
4	Slight	Hard mudstone. Joints sometimes contain thin clay films and often iron oxide staining. Strength fairly high.	Pale grey	1.5-2.5	Shatters only with very heavy blow.	Bedding clearly visible.	
5	Fresh	Very hard mudstone. Joints clean or with pyrite films or occasionally calcite. Strength very high.	Dark blue-grey	> 2.5	Fractures, but not shatters, by very hard hammer blow.		

*In engineering sense. †Colour can be much paler if leaching has occurred.

The Journal of The Institution of Engineers, Australia, Jan.-Feb., 1970

LEGEND.

RECENT	Q		Alluvium
UNDIFFERENTIATED		Age Unknown	Clay, Sandy clay, Clayey Sand.
TERTIARY	T	Black Rock Sandstone	Sandstone, clayey sandstone, Sand, sandy clay.
DEVONIAN		Unnamed Intrusion	Weathered Acid Intrusive.
DEVONIAN	Ddt	Tally Ho Quartz Diorite.	Quartz Diorite.
DEVONIAN	Dgl	Lysterfield Granodiorite	Granodiorite
DEVONIAN	Dlh	Humevale Formation	Siltstone, mudstone very minor sandstone sandstone more common at base of formation but it remains minor.
SILURIAN	Sud	Dargile Formation	Interbedded sandstones and shales sandstones are laminated and cross bedded.
SILURIAN	Sla	Anderson Ck Formation.	Massive siltstones with minor sandstones; intervals of massive sandstones (greywacke)

m Metamorphic Zones

- Dyke
- Interpreted geological boundary
- Strike and dip of bedding
- Horizontal beds
- Trend of bedding - see geological cross section (Plate II)
- Anticlinal fold.
- Synclinal fold.
- Monoclinal fold.
- Outcrop exposure of normal fault showing direction of downthrow.
- Outcrop exposure of reverse fault showing direction of dip of the fault plane.
- Postulated fault showing direction of down throw.
- Trend of topographic feature as deduced from topographic and outcrop pattern analysis
- Fossil locality.
- A 16,400 m — B Location of Geological Cross Section, showing chainages in metres.

Note:

(1) The locations of the Beaumaris Monocline and the Melbourne warp are taken from the Ringwood 1:63,360 Geological Map. The geology south of the Melbourne Warp is taken from the Cranbourne 1:63360 Geological Map.

(2) Topography taken from M.M.B.W. 1:24,000 topographic maps dated 1968. Grid from Lands Dept 1:25,000 maps.

(3) This map was compiled by A.M. Cooney of Victorian Mines Department March 1973.

SCALE 1:25,000.

INDEX	DATE	REVISION	APPD.
E			
D			
C			
B			
A			

NOTES

DRAWN	A.M. Cooney
TRACED	R.W. 15/8/73
CHECKED	
APPROVED	
JOB NO.	
REPORT NO.	

PLATE I

SURFACE GEOLOGY ALONG THE ROUTE OF THE PROPOSED DANDENONG VALLEY TRUNK SEWER.

SCALE
DRAWING NO.
SHEET OF

Vertical and horizontal scale 1: 25,000

Note: Hades of faults not known and are shown vertical for diagrammatic purposes only.

For legend see Plate I

PLATE II

GEOLOGICAL CROSS SECTION ALONG LINE A—B

(LOOKING TOWARDS THE WEST)